

SPOKANE RIVER BRIDGE AT LONG LAKE DAM
State Route 231 spanning the Spokane River
Reardon vicinity
Lincoln County
Washington

HAER No. WA-95

HAER
WASH
22-REARLY
1-

WRITTEN HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

HISTORIC AMERICAN ENGINEERING RECORD
NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
P.O. BOX 37127
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Location: Spanning the Spokane River between Lincoln and Stevens counties on state route 231, beginning at mile point 44.65.

UTM: 11/436270/5298530
11/436305/5298560

Quad: Long Lake, Wash.

Date of Construction: 1949

Engineer: Washington Department of Highways

Fabricator: Henry Hagman of Cashmere, Washington.

Owner: Washington Department of Highways.
Since 1977, the Washington State Department of Transportation, Olympia, Washington

Present Use: Vehicular and pedestrian traffic.

Significance: The bridge is a late example of an open-spandrel reinforced-concrete ribbed deck arch. Considered hinges were used at the skewbacks to relieve stresses in the arch during the construction of the bridge. The bridge has been nominated to the National Register of Historic Places.

Historian: Wm. Michael Lawrence, August 1993

History of the Bridge

The Spokane River Bridge at Long Lake Dam replaced a timber trestle bridge. It is said to be the longest concrete arch span constructed in the state from 1941 to 1950.¹ The setting for this bridge is a remote one, with the Spokane River running down a gorge which separates two very different regions. To the north, in Stevens County, are the Selkirk Mountains, an area which has made its living by lumbering, by mining zinc, lead, and copper, and by ranching sheep and cattle.² Lincoln County, to the south, is mostly a sparsely populated, arid plain with few trees. Irrigation, using water from Little Falls Lake and Long Lake, after the construction of two dams in 1910 made the fertile region into a major wheat-producing area.³ The highway across the Spokane River is one of the links between these two different regions.

The state highway department prepared a design for a new reinforced-concrete arch bridge in 1948. The engineers completed the design before 15 July 1948, when the drawings received the approval of Ray Dinsmore, the director of highways.⁴ The department did not call for bids, however, until the following year. A copy of the announcement appeared in the *Pacific Builder and Engineer*, the major contracting and engineering journal in the northwest, on 9 February 1949.⁵ Bids for this and several other projects were opened on the 4 March. Henry Hagman, of Cashmere, Washington, was the low bidder at \$233,698.74. The other bids were submitted by State Construction Co. of Seattle, at \$244,366.12, and David Nygren of the same city, at \$270,341.80.⁶ Hagman and the state signed the contract on 14 March.⁷

Design and Description

The Spokane River bridge at Long Lake dam is a late example the open-spandrel reinforced-concrete ribbed deck arch built in the United States during the early twentieth century. Considered hinges were used during its construction. Its streamlined appearance contrasts with earlier, ornamented concrete arch bridges.

The bridge is a 485' long reinforced-concrete structure, consisting of a deck supported by an open-spandrel ribbed arch and seven spans supported by bents. Its deck rests on cross beams and longitudinal girders supported by the bents and the spandrel columns. It consists of:

- one 40' reinforced-concrete deck girder span
- one 41' reinforced-concrete deck girder span

SPOKANE RIVER BRIDGE
AT LONG LAKE DAM
HAER No. WA-95
(Page 3)

one 200' reinforced-concrete ribbed deck arch span
one 41' reinforced-concrete deck girder span
three 40' reinforced-concrete deck girder spans
one 30' reinforced-concrete deck girder span

The arch is over the river and the bents are on steep slopes on either side on the channel.⁸

The deck is 31'-4" wide with a 24' wide roadway and a 4' wide sidewalk. It bears on cross beams at 10' on center framing into two rows of girders at 9' to either side of the centerline of the bridge. The deck is an 8"-thick reinforced-concrete slab. These members are monolithic. The beams are 12" x 1'-8" (wide x deep), while the girders are 1'-8" wide and vary in depth from 3' at the span to 4'-9-5/8" at the bents, the underside of each girder being a parabolic curve.⁹

The bents are, on the average, 3' x 2', with the long dimension parallel with the spans. Each has a batter of 1:144. They bear on footings in the embankments.¹⁰ The spandrel columns are similar, but rest on the arch, with the outermost panels at 25' on center and the middle seven panels at 23'.¹¹

The bents closest to the arch and the outermost spandrel columns bear on the arch abutments, adjoin each other, and are separated throughout their heights by a 1" open joint, assuring that the arch span can expand and contract independently of the approaches. The second spandrel column on either side of the crown of the arch is similarly split by a vertical joint, allowing the deck above to contract and expand.¹²

The reinforced-concrete arch rises 44' from the skewbacks to the crown at the centerline of the rib.¹³ The skewback centerlines are 5'-6" from the open joint between the arch and the rest of the bridge.¹⁴ This arch is a parabola with a radius, measured at the intrados, varying from 126'-11" at the crown to 145'-7-5/8" at the abutments. The arch also rib varies in its dimensions, from 3' x 4' (high x wide) at the crown, to 4' x 5'-8" (high x wide) at the abutments.¹⁵ The arch and its abutments bear on footings which are at an angle to the horizontal in order to counteract the outward thrust of the arch.

The arc in its completed form is fixed, having no hinges at the skewbacks or crown to permit movement. During its construction, however, it was provided with temporary hinges near its skewbacks. These hinges are a late example of their use in the United States. Two decades before, for example, Conde B. McCullough, the Oregon State Bridge Engineer from 1919 to 1936, used the type of hinge perfected by the French engineer Armand

Considered in the crowns of reinforced-concrete tied arches along the Oregon Coast Highway (U.S. 101) in the early 1930s.¹⁶

Throughout most of the rib, the bars are located near the extrados and intrados. During construction of the lowermost parts of each ribs, these bars were terminated on either side of the hinge, with a gap between them. Specially bent bars were placed with their ends inserted in this regular reinforcement. The middles of the bent bars converge at the center of the arch rib and are surrounded by circular hoops. When the concrete was poured at this hinge, notches were left in the rib, above and below the point where the bars converge. After all other parts of the bridge were poured, the workmen would return, eliminate the gap between the regular bars by splicing additional bars to their ends. This was accomplished by means of welding plates. The workmen then filled the notches with concrete.¹⁷ At the narrowest part of the hinge the steel to concrete ratio is higher, making the hinge flexible. During construction of the bridge, such hinges reduced stresses in the ribs due to shrinkage of the concrete during setting and hardening, to elastic compression in the arch due to superimposed loading, and to settlement of the abutments under the thrust of the arch.¹⁸

Overall, the bridge is rather attenuated in appearance, with its slender bents and spandrel columns. The elliptical arches formed by the underside of the girders echoes the form of the arch and creates a pleasing rhythm. The bridge has no ornament except for moldings at the top of its railings. Its streamlined appearance contrasts with bridges adorned with architectural ornamentation such as the Baker River Bridge in Concrete, Washington (HAER No. WA-105), a much earlier example of the open-spandrel reinforced-concrete ribbed arch, built in 1916.¹⁹ The two bridges represent the early and late years of this type of construction.

Repair and Maintenance

The bridge is in good condition with some minor cracking, efflorescence, and spalling. The deck has been worn down to the aggregate, exposing a few reinforcing bars.²⁰

Data limitations:

The most helpful sources for this report were the working drawings, the contract, and the final estimate, which survive at the Washington State Department of Transportation archives, and two entries in the *Pacific Builder and Engineer*. The drawings made it possible to describe and analyze the structure. All of these documents made it possible to establish its dates.

A search of engineering and contractors' journals failed to discover any articles regarding this bridge. The clipping files at the Washington State Library in Olympia, the Washington State Historical Society at Tacoma, the Museum of History and Industry in Seattle, and the Special Collections Room at the University of Washington in Seattle, and the Seattle Public Library contained newspaper articles regarding many other bridges, but not this one.

Project Information

This project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States. The Washington State Historic Bridges Recording Project was co-sponsored in 1993 by HAER, the Washington State Department of Transportation (WSDOT), and the Washington State Office of Archeology & Historic Preservation. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Robert J. Kapsch, Ph.D., Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; and Dean Herrin, Ph.D., HAER Staff Historian.

The recording team consisted of Karl W. Stumpf, Supervisory Architect (University of Illinois at Urbana-Champaign); Robert W. Hadlow, Ph.D., Supervisory Historian (Washington State University); Vivian Chi (University of Maryland); Erin M. Doherty (Miami University), Catherine I. Kudlik (The Catholic University of America), and Wolfgang G. Mayr (U.S./International Council on Monuments and Sites/Technical University of Vienna), Architectural Technicians; Jonathan Clarke (ICOMOS/Ironbridge Institute, England) and Wm. Michael Lawrence (University of Illinois at Urbana-Champaign), Historians; and Jet Lowe (Washington, D.C.), HAER Photographer.

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- Hadlow, Robert William. "Conde B. McCullough, 1887-1946: Master Builder of the Pacific Northwest." Ph.D. diss., Washington State University, 1993).
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- Walter, Donald E. (ed.) *Lincoln County: A Lasting Legacy*. Davenport, Washington: Lincoln County Centennial Committee, 1988.
- Washington State and Henry Hagman. Bid proposal (2 March 1949) and Contract (8 March 1949) for Spokane River Bridge at Long Lake Dam [No. 231/101]. Copy held by Records Control, Washington State Department of Transportation, Olympia, WA [WSDOT].
- Washington. Department of Highways. "Secondary State Highway No. 3-J, Spokane River Bridge at Long Lake" (approved 15 July 1948). 15 sheets of drawings, held by Records Control, WSDOT.

SPOKANE RIVER BRIDGE
AT LONG LAKE DAM
HAER No. WA-95
(Page 7)

Washington. Department of Highways. *Twenty-third Biennial Report of the Director of Highways, 1948-1950.*

Washington. State Department of Transportation. Bridge Preservation Section. Bridge Files.

ENDNOTES

¹ Department of the Interior, National Park Service, "National Register of Historic Places Nomination Form for Spokane River Bridge at Long Lake Dam, Lincoln and Stevens counties, Washington," 1991.

² Fred C. Bohm and Craig E. Holstine, *The People's History of Stevens County* (Colville, WA: Stevens County Historical Society, 1983).

³ Donald E. Walter, *Lincoln County: A Lasting Legacy* (Davenport, WA: Lincoln County Centennial Committee, 1988).

⁴ Washington Department of Highways, "Secondary State Highway No. 3-J, Spokane River Bridge at Long Lake" (approved 15 July 1948 by the director of highways), 15 sheets of drawings, copies held by Records Control, Washington State Department of Transportation, Olympia, WA [WSDOT].

⁵ Office of the Director of Highways, Olympia, Washington, "Notice to Contractors," in "Construction News Bulletin," *Pacific Builder and Engineer* 55 (19 February 1949): 16.

⁶ "Construction News Bulletin," *Pacific Builder and Engineer* 55 (12 March 1949): 2.

⁷ State of Washington and Henry Hagman, Contract (8 March 1949). Copy at Records Control, Washington State Department of Transportation, Olympia; the contractor completed the project in May of 1950 and on 1 June 1950 D. A. Kelley, the resident engineer, reported a final cost estimate of \$233,175.09 to the Director of Highways. See Washington Department of Highways, *Twenty-third Biennial Report of the Director of Highways, 1948-1950*, 24.

⁸ Washington Department of Highways, "Secondary State Highway No. 3-J, Spokane River Bridge at Long Lake" (approved 15 July 1948 by the director of highways), sheet 1, copies held by Records Control, WSDOT.

⁹ Ibid., sheet 4 and 5.

¹⁰ Ibid., 4.

¹¹ Ibid., 1.

¹² Ibid., 7. The details are in the "Longitudinal Section Thru Half Arch.

¹³ Ibid.

¹⁴ Ibid., sheet 1.

¹⁵ Ibid., sheet 7.

¹⁶ Robert William Hadlow, "Conde B. McCullough, 1887-1946: Master Builder of the Pacific Northwest" (Ph.D. diss., Washington State University, 1993), 160-63.

¹⁷ Ibid., "Detail of Considère Hinge" and "Welding Details for Rib Steel at Hinge." For an axonometric illustration of the Considère hinge, see "Alsea Bay Bridge, HAER No. OR-14," sheet 2 of 2, Todd A. Croteau, et al., delineators, in the Historic American Engineering Record, Prints and Photographs Division, Library of Congress.

¹⁸ W. L. Scott and C. W. Spicer, *Reinforced Concrete Bridges* (London: Crosby Lockwood & Son, 1925), 156-57.

¹⁹ See Department of the Interior, National Park Service, Historic American Engineering Record, "Baker River Bridge, HAER No. WA-105," by Wm. Michael Lawrence, 1993.

²⁰ "Spokane River Bridge at Long Lake Dam, No. 231/101," Bridge Preservation Section, WSDOT.